A Novel Impedance Matching Approach with Oblique Waveguide for Arbitary Rectangular Waveguide Devices

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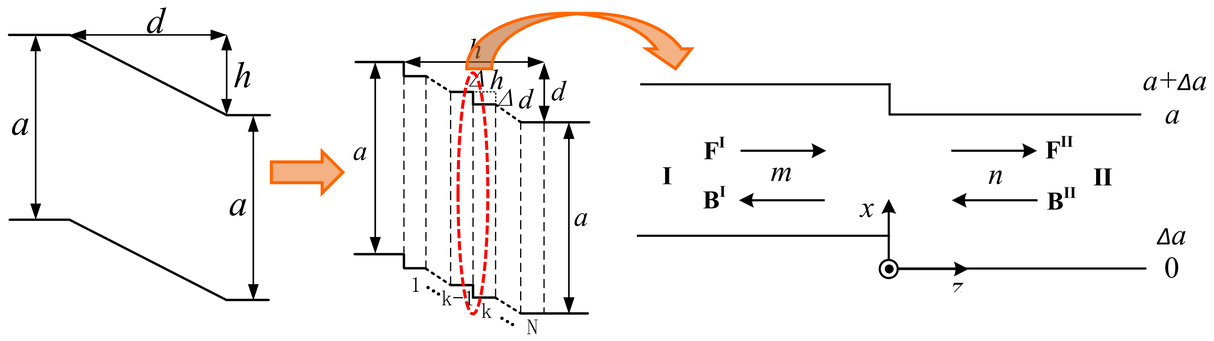
Introduction

A numerical model of generalized scattering matrix for the H-plane oblique waveguide is established, based on the mode matching method and the scattering matrix cascade principle of microwave network. And the impedance matching characteristics of the H-plane oblique waveguide are described detailedly. Besides, an optimum design method and procedures of the oblique waveguide utilizing to match an arbitary rectangular waveguide device is proposed.

Theory

The H-plane oblique waveguide is divided into N stepped waveguides, each of which is composed of a H-plane waveguide discontinuous surface and a short straight rectangular waveguide. For the H-plane waveguide discontinuous surface, its scattering matrix numerical model can be obtained by the mode matching method(MMM).



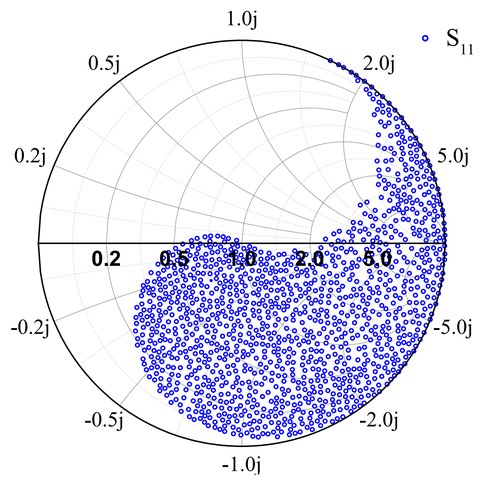
The scattering matrix S of the H-plane oblique waveguide could be deduced by the follow expression.

$$S = S^1 \otimes S^2 \cdots \otimes S^N$$

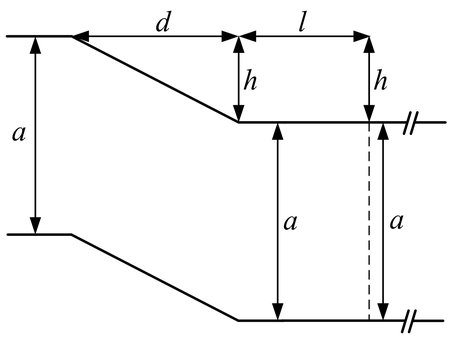
⊗ stands for cascading the scattering matrix.

Analysis

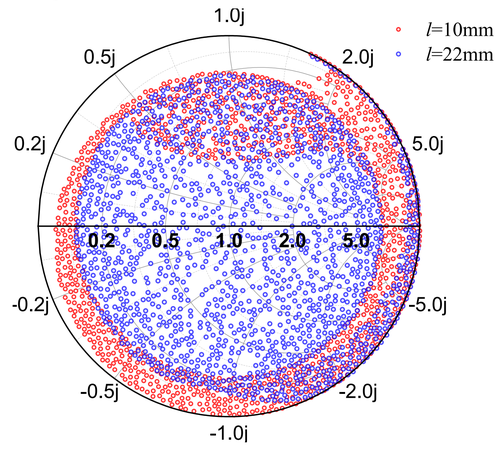
By the Monte Carlo method, we can calculate and draw the Smith circle diagram of the oblique waveguide. It shows that only part of the Smith circle diagram is filled, which indicates that adjusting the size of *h* & *d* alone cannot achieve impedance matching for an arbitrary rectangular waveguide device.



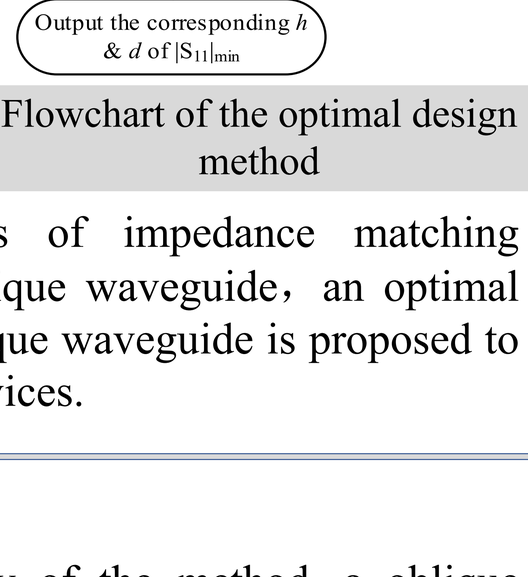
To solve this problem, the inclined-waveguide is improved by adding a straight waveguide whose length is *l* between the output port of the original oblique waveguide and the input port of the waveguide device.



Through adjusting the size of *l*, *h* and *d* to suitable values, the improved oblique waveguide can realize impedance matching for an arbitrary rectangular waveguide device.



Smith circle diagram varying with *d* and *h* at different *l*

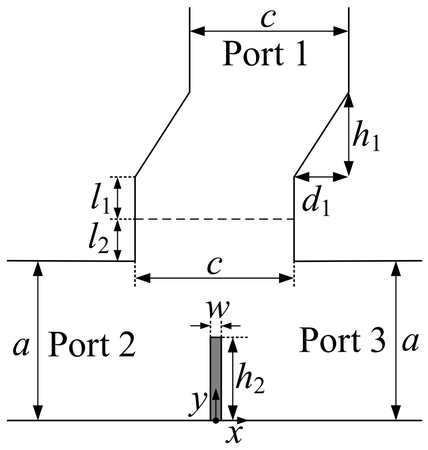


Flowchart of the optimal design method

Based on the above analysis of impedance matching characteristics of the improved oblique waveguide, an optimal design method of the improved oblique waveguide is proposed to match the rectangular waveguide devices.

Example

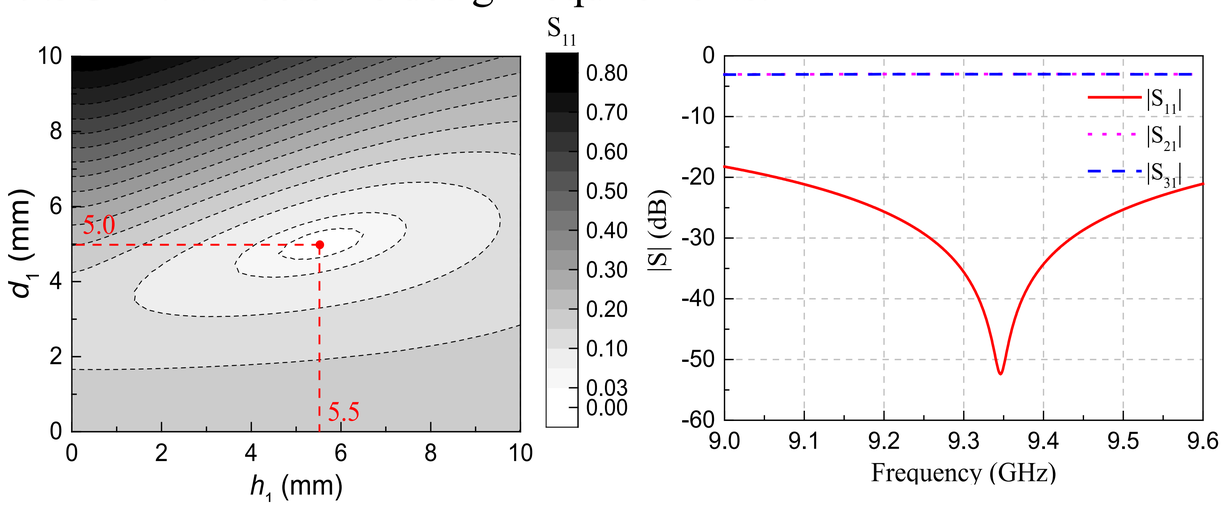
In order to verify the feasibility of the method, a oblique waveguide is used instead of the traditional inductance diaphragm to design a waveguide H-T 3dB power divider.



Known parameters of the waveguide H-T 3dB power divider.

Paras.	Values	Paras.	Values
a	22.86mm	c	22.86mm
h_2	12mm	*w*	2mm
l_2	10mm	frequency	9.3GHz

Adopting the optimal design method, we find suitable parameters of l_2, h_1 and d_1. And the $|S_{11}|$ is less than -35dB at 9.3GHz. It meets the design requirements.



Conclusion

The scatting parameters numerical model and impedance matching characteristics of the H-plane oblique waveguide are investigated in this paper. In order to achieve the matching of any rectangular waveguide devices, we developed an improved oblique waveguide and an optimal design method. Moreover, an application example of designing a waveguide H-T 3dB power divider proves the effectiveness of the method.